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DRYNESS DETECTING SENSOR FOR A CLOTHES DRYER

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[There are no amendments to this patent.]

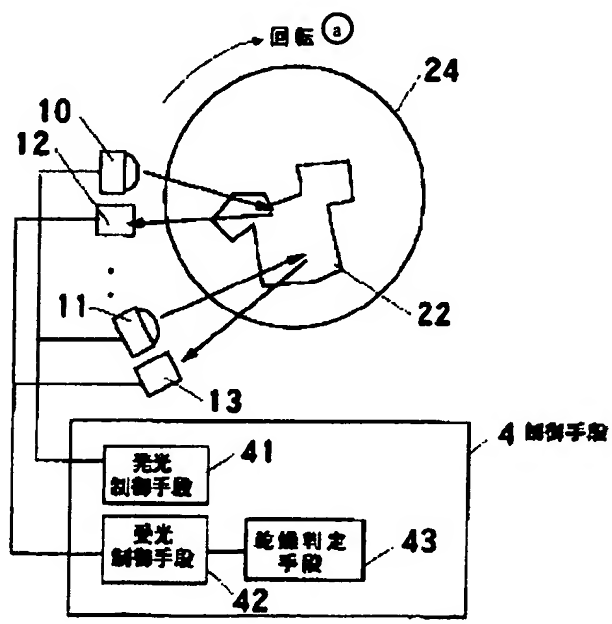
Abstract

Purpose

To provide a type of dryness sensor for a clothes dryer that can correctly detect dryness, and, in particular, that can cope with the special case of a small quantity of clothes.

Constitution

The sensor is composed of light-emitting means (10), (11) that emit light towards object (22), light-receiving means (12), (13) that generate outputs corresponding to the amount of light reflected by or transmitted through the object which received the light emitted from the light-emitting means, control means (4) that turns light-emitting means (10), (11) on and off and detects the output of said light-emitting means; wherein said control means (4) determines the water content in said object (22) from the change in the output from said light-receiving means (12), (13). Due to said constitution, by attenuating the amount of light of the reflected or transmitted by object (22) and detecting the attenuation degree, it is possible to determine the water content in the object (22).



Key:
- a Rotation
- 4 Control means
- 41 Light-emitting control means

42 Light-receiving control means
43 Dryness judgment means

Claims

1. A dryness detecting sensor for a clothes dryer characterized by the fact that it comprises a light-emitting means that emits light towards an object, a light-receiving means that generates an output corresponding to the amount of light reflected from or transmitted through the object which received the light emitted from the light-emitting means, a control means that turns said light-emitting means on and off and detects the output of said light-emitting means; wherein said control means determines the water content in said object from the change in the output of said light-receiving means.

2. The dryness detecting sensor for a clothes dryer described in Claim 1 characterized by the fact that [plural] light-emitting means emit light in different wavelength regions toward the object, and that there is a control means that turns the plural light-emitting means on and off and detects the output of said light-receiving means; wherein said control means turns on said plural light-emitting means by time division and determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means.

3. The dryness detecting sensor for a clothes dryer described in Claim 1 characterized by the fact that each of the light-receiving means has plural different wavelength region sensitivity values and generates an output corresponding to the amount of light reflected from or transmitted through the object which received the light emitted from the light-emitting means and that the control means turns the light-emitting means on and off, detects the outputs of the plural light-receiving means, and determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means.

4. A dryness detecting sensor for a clothes dryer characterized by the fact that it comprises plural light-emitting means that emit light in different wavelength regions towards an object, plural light-receiving means that generate outputs corresponding to the amount of light reflected by or transmitted through the object which received the light emitted from the plural light-emitting means, a control means that turns said plural light-emitting means on and off and detects the outputs of said plural light-emitting means; wherein said control means determines the water content in said object from the change in the difference or ratio of the outputs of said plural light-receiving means.

5. A dryness detecting sensor for a clothes dryer characterized by the fact that it comprises a light-emitting means that emits light towards an object, plural bandpass filters for passing light of different wavelength regions, a light-receiving means that generates outputs corresponding to the amount of light passing through said plural bandpass filters, a filter

switching means that alternately places the plural bandpass filters in the optical paths of the light emitted from the light-emitting means that is reflected from or transmitted through the object, and a control means that turns the light-emitting means on and off, detects the outputs of the light-receiving means and controls the filter switching means of the plural bandpass filters; wherein said control means determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means that have received the light that has passed through said plural bandpass filters.

6. A dryness detecting sensor for a clothes dryer characterized by the fact that it comprises a light-emitting means that emits light towards an object, plural bandpass filters for passing light of different wavelength regions, plural light-receiving means that generate outputs corresponding to the amount of light in the different wavelength regions after passing through said plural bandpass filters, and a control means that turns said light-emitting means on and off and detects the outputs of the plural light-receiving means; wherein said plural bandpass filters are placed in the optical paths of the light emitted from said light-emitting means that is reflected from or transmitted through said object; and wherein said control means determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means.

7. The dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the light-emitting means and light-receiving means are set on the outside of said drum, and the incidence or blocking of the reflected light or transmitted light with respect to said light-receiving means is performed by means of holes formed in said drum.

8. The dryness detecting sensor for a clothes dryer described in Claim 5 characterized by the fact that the drum-type dryer, which rotates and tumbles clothes in a drum to dry them, contains a filter switching means that switches said bandpass filters in the optical paths by installing plural bandpass filters in the holes formed in said drum.

9. The dryness detecting sensor for a clothes dryer described in any of Claims 2-6 characterized by the fact that the control means has a correcting means that corrects the ratio of the outputs of the plural light-emitting means or the plural light-receiving means by means of the light receiving output during the period when no light is incident on the object, such as before the start of operation.

10. The dryness detecting sensor for a clothes dryer described in Claim 9 characterized by the fact that the correcting means adopts a control method in which the power applied to the light-emitting means is adjusted so that the light receiving outputs are the same when no light is incident on the object.

11. The dryness detecting sensor for a clothes dryer described in Claim 9 characterized by the fact that the correcting means computes the weights of the outputs of the light-receiving means corresponding to the light receiving output during the period when no light is incident on the object.

12. The dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that the method of computation for evaluating dryness is changed according to the output value, variation rate over time, etc. of the light-receiving means at the start of operation.

13. The dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the optical paths of the light-emitting means or light-receiving means are placed in positions away from the holes for blowing air.

14. The dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the optical paths of the light-emitting means and light-receiving means are placed in positions facing the lower part of the drum where the object falls.

15. The dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the dryness is detected with the rotation of said drum stopped, so that the object is still.

16. The dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the rotational velocity of said drum is controlled so that the object passes by its own weight through the optical paths of said light-emitting means and light-receiving means.

Detailed explanation of the invention

[0001]

Technical field of the present invention

The present invention pertains to a dryness detection system that detects the water content of or the amount of water in the object by means of the difference in the absorption of light due to the water content in different wavelength regions and the change in the transmitted or reflected light due to the water content. It can be used in clothes dryers and other products that require detection of dryness.

[0002]

Prior art

In conventional clothes dryers, the temperature in the dryer drum and the intake/exhaust air temperatures that vary over the process of drying are detected with temperature sensors, and from the pronounced change point or change rate, the degree of dryness is predicted.

[0003]

In the following, an explanation will be given regarding an example of this system with reference to the constitution of a drum-type dryer commonly used as a home clothes dryer. As shown in Figure 2, external air drawn in and heated by a heater is blown over the clothes while the clothes are tumbled in drum (2) inside the main body of the dryer. The water contained in the clothes is heated and evaporated by the heat of the warm air. Due to the evaporation of water, the warm air has certain humidity. The humid warm air then enters a heat exchanger, i.e., a cooling fan or the like, and is cooled. As the temperature falls, the air super-saturates forming water droplets. As a result, the moisture is removed.

[0004]

In addition to the aforementioned heat exchanger system, the following forced air exhaustion drying system is also commonly adopted: the warm air with absorbed moisture is blown out and discharged from the dryer; in its place, the ambient, less humid fresh air is drawn in.

[0005]

Figure 3 is a diagram illustrating a typical example of the change in temperature inside the drum during the drying process in the clothes dryer shown in Figure 2. The abscissa indicates lapsed time, and the ordinate represents temperature. In Figure 3, interval 1 represents the heating-drying period. During this period, because the temperature in the drum is still low, sufficient evaporation does not take place, and the thermal energy of the warm air is used as gasification energy, so that the temperature in the drum increases. During interval 2, accompanying the rise in the temperature in the drum, the amount of evaporated water increases, so that a balance is realized between the thermal energy fed from the warm air and the gasification energy of the water content, and the temperature in the drum becomes nearly constant. During interval 3, as the end of drying approaches, the water in the drum drops, so that the amount of water removed corresponds to the thermal energy of the warm air used as the gasification energy, and part of the thermal energy is used to raise the temperature of the interior of the drum.

[0006]

With the temperature variation of the clothes dryer of the prior art as shown in Figure 3, at interval 3, the temperature rises relatively quickly, which occurs immediately before the end of drying. Consequently, the operation of the clothes dryer continues until the predicted time after entering interval 3, and then comes to an end.

[0007]

Problems to be solved by the invention

However, in practice, depending on the type of clothes and their degree of wetness at the start of operation, sufficient moisture evaporation may not take place. As a result, the temperature in the drum may not vary as shown in Figure 3. Consequently, drying behavior cannot be detected with the aforementioned detection method at all. Especially for a few pieces of clothing or semi-dry clothes, since the proportion of the influence of evaporation of moisture on the change in temperature is much less than that of the thermal capacity of the interior of the drum, the variation in temperature cannot be detected, which is undesirable.

[0008]

Also, even in the case of temperature variation shown in Figure 3, the entry into interval 3 takes place near the end of drying. As a result, it is impossible to detect low levels of dryness, where shrinkage of wool clothes starts to occur, which is undesirable.

[0009]

In addition, with respect to synthetic fibers and other fibers that dry easily, since the initial wetness is lower, a rapid rise in temperature starts without entering the constant-rate drying period indicated as interval 2 in Figure 3, and the temperature adjustment control is performed by turning the heater on and off so that the temperature inside the drum is kept at a level where the clothes are not damaged. In the control of the temperature adjustment, due to the disturbance caused by turning the heater on and off the temperature in the drum does not exhibit the behavior of the temperature in the drum shown in Figure 3, which is undesirable.

[0010]

However, with a dryness detecting system using light as in the present invention, since detection is performed by means of the light directly irradiated on the clothes or other object, it is possible to detect dryness without the influence of such factors as number of articles of clothing,

wetness, etc. This is different from indirect detection using the change in temperature, humidity, etc., in the drum.

[0011]

In addition to the aforementioned problems pertaining to dryness detection, there are the following problems for the sensor using light adopted in the present invention: when light or another source of irradiation is applied continuously for a prescribed period of time, the effects of hysteresis will adversely take place. For example, the output characteristics become saturated and drop off, or variations will occur. As a result, it is necessary to use a chopping means, such as shutter or the like, for turning the incident light on the light-receiving means on and off at prescribed intervals.

[0012]

As the raw material used to make said shutter or the like, a bimetal or another conductive material that deforms and bends in one direction when a voltage is applied in a prescribed direction may be used. By the alternate application of forward/reverse voltages the bimetal will warp and return to its original state, so that the shutter can turn on/off in a locked way. This chopping mechanism has been adopted in practical application.

[0013]

However, the bimetals used in the aforementioned methods are expensive, compared with the conventional temperature detection system that use thermistors, so that the cost of the sensor is tens of times higher, which is undesirable for practical applications.

[0014]

However, conventional home clothes dryers use a drum-type dryer for drying clothes, as shown in Figure 2. Thus, the rotating mechanism part of the rotating type drum can be used so that the light is chopped on and off by the holes on the side wall. As a result, it is possible to form a chopping mechanism with a simpler constitution as the electrical shutter, and other parts can be omitted.

[0015]

Means to solve the problems

In order to solve the aforementioned problems, the present invention has a constitution in which light is irradiated on the object, and from the change in the amount of light reflected or transmitted through the object which received the light emitted from the light-emitting means,

the water content of said object can be determined. As a result, it is possible to realize appropriate drying corresponding to the type of clothes.

[0016]

Embodiment of the present invention

The invention as described in Claim 1 of the present patent application provides a dryness detecting sensor for a clothes dryer characterized by the fact that it comprises a light-emitting means that emits light towards an object, a light-receiving means that generates an output corresponding to the amount reflected from or transmitted through the object which received the light emitted from the light-emitting means, a control means that turns said light-emitting means on and off and detects the output of said light-emitting means; wherein said control means determines the water content in said object from the change in the output of said light-receiving means. As a result, from the increase or decrease in the amount of light reflected from or transmitted through the object which received the light emitted from the light-emitting means, which corresponds to the water content of the object, it is possible to determine the water content of the object by detecting the attenuation proportion.

[0017]

The invention as described in Claim 2 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in Claim 1 characterized by the fact that [plural] light-emitting means emit light from different wavelength regions toward the object, and that there is a control means that turns the plural light-emitting means on and off and detects the outputs of said light-receiving means; said control means turns on said plural light-emitting means by time division and determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means. As a result, by emitting light from different wavelength regions that undergoes different attenuation rates due to water content and by correcting for the attenuation proportion caused by factors other than water, it is possible to determine the water content of the object more accurately.

[0018]

The invention as described in Claim 3 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in Claim 1 characterized by the fact that each of the light-receiving means has plural different wavelength region sensitivity values and generates an output corresponding to the amount of light reflected from or transmitted through the object which received the light emitted from the light-emitting means; and that the control means turns the light-emitting means on and off, detects the outputs of the plural light-receiving

means, and determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means. As a result, by receiving the light with plural light-receiving means corresponding to wavelength regions that have different attenuation rates due to water content and by correcting for the attenuation proportion caused by factors other than water, it is possible to determine the water content of the object more accurately.

[0019]

The invention as described in Claim 4 of the present patent application provides a type of dryness detecting sensor for a clothes dryer characterized by the fact that it comprises plural light-emitting means that emit light in different wavelength regions towards an object, plural light-receiving means that generate outputs corresponding to the amount of light by reflecting from or transmitted through the object which receives the light emitted from the plural light-emitting means, a control means that turns said plural light-emitting means on and off and detects the outputs of said plural light-emitting means; wherein said control means determines the water content in said object from the change in the difference or ratio of the outputs of said plural light-receiving means. As a result, by irradiating light from wavelength regions that have different attenuation rates due to water content and by receiving the light with plural light-receiving means corresponding to said wavelength regions, respectively, it is possible to determine the water content of the object more accurately.

[0020]

The invention as described in Claim 5 of the present patent application provides a dryness detecting sensor for a clothes dryer characterized by the fact that it comprises the following parts: a light-emitting means that emits light towards an object, plural bandpass filters for passing light from different wavelength regions, a light-receiving means that generates outputs corresponding to the amount of light passing through said plural bandpass filters, a filter switching means that alternately places the plural bandpass filters in the optical paths of the light emitted from the light-emitting means that is reflected from or transmitted through the object, and a control means that turns the light-emitting means on and off, detects the outputs of the light-receiving means and controls the filter switching means of the plural bandpass filters; wherein said control means determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means that have received the light that has passed through said plural bandpass filters. As a result, from the light irradiated onto the object, plural wavelength regions with different attenuation rates caused by water content are made to pass through plural bandpass filters selectively and are received, so that the attenuation

proportion due to attenuation factors other than water can be corrected, and it is possible to determine the water content of the object more accurately.

[0021]

The invention described in Claim 6 of the present patent application provides a dryness detecting sensor for a clothes dryer characterized by the fact that it comprises a light-emitting means that emits light towards an object, plural bandpass filters for passing light of different wavelength regions, plural light-receiving means that generate outputs corresponding to the amount of light in the different wavelength regions after passing through said plural bandpass filters, and a control means that turns said light-emitting means on and off and detects the outputs of the plural light-receiving means; wherein said plural bandpass filters are placed in the optical paths of the light emitted from said light-emitting means that is reflected from or transmitted through said object; and whereby said control means determines the water content of said object from the change in the difference or ratio of the outputs of said plural light-receiving means. As a result, from the light irradiated on the object, plural wavelength regions with different attenuation rates due to water content are made to pass through plural bandpass filters selectively, so that by receiving the light with the light-receiving means corresponding to said wavelength regions, it is possible to correct the attenuation proportion caused by attenuation factors other than water, and it is possible to determine the water content of the object more accurately.

[0022]

The invention as described in Claim 7 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the light-emitting means and light-receiving means are set on the outside of said drum, and the incidence or blocking of the reflected light or transmitted light with respect to said light-receiving means is performed by means of the holes formed in said drum. As a result, it has light-receiving means for receiving IR light emitted corresponding to the temperature of the object and a control means that detects the outputs of said light-receiving means, so that it is possible to determine the water content of the clothes from the change in the output of said control means.

[0023]

The invention as described in Claim 8 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in Claim 5 characterized by the fact that the drum-type dryer, which rotates and tumbles clothes in a drum to dry them, contains a filter

switching means that switches said bandpass filters in the optical paths by attaching the plural bandpass filters to the holes formed in said drum. The invention as described in Claim 9 of the present patent application pertains to the dryness detecting sensor for a clothes dryer as described in any of Claims 2-6 characterized by the fact that the control means has a correcting means that corrects the ratio of the outputs of the plural light-emitting means or the plural light-receiving means by means of the light receiving output during the period when no light is incident on the object, such as before the start of operation.

[0024]

The invention as described in Claim 10 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in Claim 9 characterized by the fact that the correcting means adopts a control method in which the power applied to the light-emitting means is adjusted so that the light receiving outputs are the same when no light is incident on the object.

[0025]

The invention as described in Claim 11 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in Claim 9 characterized by the fact that the correcting means computes the weights of the outputs of the light-receiving means corresponding to the light receiving output during the period when no light is incident on the object.

[0026]

The invention as described in Claim 12 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that the method of computation for evaluating dryness is changed according to the output value, variation rate over time, etc. of the light-receiving means at the start of operation.

[0027]

The invention as described in Claim 13 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the optical paths of the light-emitting means or light-receiving means are set away from the holes for blowing air.

[0028]

The invention as described in Claim 14 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the optical paths of the light-emitting means and light-receiving means are set facing the lower portion of the drum where the object falls.

[0029]

The invention as described in Claim 15 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, dryness is detected with the rotation of said drum stopped, so that the object is still.

[0030]

The invention as described in Claim 16 of the present patent application pertains to the dryness detecting sensor for a clothes dryer described in any of Claims 1-6 characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the rotational velocity of said drum is controlled so that the object passes by its own weight through the optical paths of said light-emitting means and light-receiving means.

[0031]

Application examples

In the following, the present invention will be explained in more detail with reference to application examples illustrated by figures.

[0032]

Figure 1 is a block diagram illustrating the principle of the case when the reflected light from the clothes is exploited in the present invention. Figure 2 is a diagram illustrating the constitution of a drum type warm air feeding system clothes dryer as an example to elucidate the present invention.

[0033]

Figure 1 shows an example of the drum-type warm-air clothes dryer shown in Figure 2. As shown in the figure, (10) and (11) represent LEDs, electric light bulbs or other light-emitting means for irradiating clothes with IR light; (12) and (13) represent light-receiving means for receiving the light emitted from light-emitting means (10), (11) and reflected from or transmitted

through the clothes; (24) represents a rotating drum that agitates the clothes and blows warm air uniformly onto the clothes; and (22) represents schematically the clothes in the clothes dryer.

[0034]

Figure 2 is a diagram illustrating the constitution of the drum-type clothes dryer as a typical clothes dryer for home use. As shown in the figure, (21) represents the front door for loading clothes; (22) schematically represents the clothes; (24) represents the drum for agitating clothes (22); (23) represents a baffle for blowing warm air into the drum, which may be set in more than one location. (25) represents a rotary shaft for supporting and rotating drum (24); (26) represents an air port for drawing in/exhausting air; (27) represents a cooling fan for heat exchange. (28) represents a control board for overall control of the clothes dryer. The dryness detecting sensor is set on said control board (27).

[0035]

It is well known that water and other substances absorb IR light corresponding to the wavelength of the molecular vibrations in the substances. That is, the absorption depends upon wavelength. Consequently, by selecting IR LEDs with different wavelengths, in particular, a wavelength with high absorption by water and a wavelength with low absorption by water, that is, by selecting IR LEDs that emit light at said wavelengths and comparing the outputs corresponding to the amount of light received at the two wavelengths, it is possible to detect the water content of the clothes.

[0036]

If the aforementioned constitution is adopted and the aforementioned two selected wavelengths are relatively near each other, it is possible to eliminate errors. In fact, the light emitted from the IR LED is not only absorbed by water, but also attenuated due to reflection from within and at the surface of the fibers of the clothes themselves, and the influence of such factors depends significantly on the distance between the light emitting source and the clothes as well as the angle of incidence, material type, color, etc.

[0037]

Because the influence of such factors other than water will be similar for nearby wavelengths, when a comparison is made using the wavelength not absorbed by water as the reference light and the wavelength absorbed by water as the detection light based on the input of the reference light with affected by the factors other than water, the detection light will be affected by these same factors other than water but will also be affected by the attenuation by

water. Consequently, if the output of the reference light at this time is used as a reference to determine the attenuation level of the detection light, it is possible to detect the dryness level of the clothes.

[0038]

In the following, an explanation will be given regarding an example in which the detection distances are different. Usually, as this distance increases, light will become more scattered and attenuated. Consequently, the influence of distance can be eliminated by comparison with the reference light. Figure 8 is a diagram illustrating typical examples of variation in the proportions of the detection light and reference light. Here, (a), (b) show the output proportions of the detection light and reference light in the dry state and the wet state at distance D, and (c), (d) show those at the same distance d (D<d). In Figure 8, attenuation caused by light absorption in the dry state and the wet state is assumed to be 20%. Comparison of (a) and (c) indicates that because the factors other than water affecting attenuation level, such as distance, etc., are nearly the same, the output in the dry state and the output in the wet state will be similarly attenuated. Also, as (a) and (b), (c) and (d), are influenced by water absorption, the output is attenuated by 20% from the reference light of detection distances D, d at the time.

[0039]

In said constitution, since the correlation between the proportions of the reference light and detection light and the water content of clothes at each time point is adopted, the relationship shown in Figure 7 is obtained. As shown in Figure 7, the abscissa represents water content, and the ordinate represents the ratio of detection light/reference light. As explained above with reference to Figure 8, because the difference between the reference light and the detection light is due to water absorption, as the clothes becomes drier, that is, as their water content becomes smaller, the ratio approaches 1.

[0040]

The explanation above was for the case when the light-receiving quantities of the reference light and the detection light are the same during drying as shown in Figures 7 and 8. In the following, an explanation will be given regarding the case when the amount of light varies due to selection of the light-emitting means and light-receiving means. In this case, it is possible to correct the amount of light in the dry state by any of the following methods: in one method, the reflected light from the wall of the drum during the period outside the detection period is taken as the output in the dry state of the reference light and detection light, and a computation is performed for correction. In another method, the voltage applied to the light-emitting means is

adjusted. In yet another method, in the manufacturing process, a correction process is used, and the correction coefficients are stored in a microcomputer, etc.

[0041]

In the following, an explanation will be given regarding the constitution in which a two-color system is used with different wavelengths for the reference light on the basis of Figures 4-6. Figure 4 is a diagram illustrating the constitution in which selection of the wavelength is realized for the light-emitting wavelength of the IR LED as the light source itself. Figures 4(b), (c) illustrate an example of the characteristics of the light-emitting means and light-receiving means adopted in said constitution. Figure 4(b) shows the light-emitting characteristics of the IR LED at peak light-emitting wavelength λ1 as the reference light, and the light-emitting characteristics of the IR LED at peak wavelength λ2 as the detection light. Figure 4(c) shows the light-receiving characteristics of the phototransistor that has the same sensitivity for these two IR LEDs. Consequently, when light-receiving elements with the wavelength characteristics shown in Figure 7 are used, it is possible to obtain the output of light in the wavelength region shared by (a) and (c), and (b) and (c).

[0042]

Figure 5 is a diagram illustrating the constitution for wavelength selection by means of the light-receiving sensitivity characteristics of the phototransistor as the light-receiving means. Figure 6 is a diagram illustrating the constitution of wavelength selection by embedding bandpass filters each allowing the passage of only a prescribed wavelength region on the drum side wall.

[0043]

The explanation above was based on a 2-color system using a single wavelength region for the reference light and for the detection light. However, a 3-color system, using two wavelength regions for the reference light and one wavelength region for the detection light can also be used, as well as multi-color systems. When said idea cannot be adopted due to for such reasons as the adopted wavelengths are not nearby, etc., although the attenuation due to the factors other than water is constant, one may adopt a 3-color system to perform corrections. For example, in the 3-color type system, two reference beams are selected, between which is the wavelength of the detection light, so that the variation of the influence due to factors other than water can be computed for the reference beams. Then, by means of the proportionality relationship, the attenuation rate at the wavelength of the detection light is estimated

corresponding to the portion between them. In this way, it is possible to improve the detection precision.

[0044]

The explanation above was based on a rotating drum dryer as the first embodiment. However, the drying system and mechanism design of the dryer are not limited to the aforementioned constitution. It may also be applied to the type of dryer that is upright or suspended. In particular, because the present system pertains to a direct detection method in which the reference light or transmitted light from the clothes is detected, the method differs from the indirect method for detecting the change in temperature versus the heat capacity of the interior of the dryer drum in the prior art in that it is hardly affected by the size of the main body, the setting position, size and number of air blowing baffles, and other design parameters that may vary. In particular, the effect is significant for home electrical products which frequently change in design in case of model changes, etc.

[0045]

As the wavelengths for the detection light, 1.9 μm, 1.4 μm, and other wavelengths with high absorption by water are adopted. On the other hand, as the reference light, the wavelengths of 1.8 μm, 1.3 μm, etc. are usually selected. However, since there are also many other wavelengths with high water absorption, the present invention is not limited to said wavelengths, and appropriate selection may be made corresponding to the characteristics of the light-emitting means and light-receiving means (reference: H. Hisano: "Sekigaisen Kogaku" [IR Engineering], published by Electronic Information Communication Society).

[0046]

The explanation above concerned the case in which the attachment position is on the lower side out of the outside of the drum. However, it is not limited to this position. In consideration of fact that the air feeding port in the lower part of the drum is under the influence of the external disturbance of falling temperature due to air feeding from the air blowing port, another effective scheme is to avoid this position and attach it to the opposite surface in the direction of the central axis of rotation of the drum.

[0047]

Also, by setting the optical path at the position perpendicular to the axis of the drum, since clothes fall to the lower part of the drum under their own weight, it is possible to irradiate the clothes with light with high precision.

[0048]

Finally, as a method other than that based on the water absorption principle, one may make use of the well-known phenomenon of contraction and expansion of fibers by water. That is, by means of the phenomenon that the transmitted or reflected light varies corresponding to the water content of the clothes, one may control the detection of dryness from the change in the reflected light and transmitted light.

[0049]

Effects of the invention

As explained above, according to the invention described in Claim 1, by means of the attenuation of the amount of light reflected or transmitted through the object which received the light emitted from the light-emitting means corresponding to the water content of the object, it is possible to determines the water content of the object by detecting the attenuation proportion, and it is possible to provide a dryness detecting sensor for a clothes dryer.

[0050]

According to the invention as described in Claim 2, by emitting light beams in different wavelength regions with different attenuation rates due to water content, and correcting the attenuation proportion caused by the attenuation factors other than water, it is possible to determine the water content of the object more accurately, and it is possible to provide a dryness detecting sensor for a clothes dryer.

[0051]

According to the invention as described in Claim 3, by receiving the light with plural light-receiving means corresponding to the wavelength regions exhibiting different attenuation rates due to water content, and correcting for the attenuation proportion caused by attenuation factors other than water, it is possible to determine the water content of the object more accurately, and it is possible to provide a type of dryness detecting sensor for a clothes dryer.

[0052]

According to the invention described in Claim 4, by irradiating light in wavelength regions with different attenuation rates due to content and receiving the light with plural light-receiving means corresponding to said wavelength regions, respectively, it is possible to determine the water content of the object more accurately, and it is possible to provide a dryness detecting sensor for a clothes dryer.

[0053]

According to the invention as described in Claim 5, from the light irradiated on the object, plural wavelength regions with different attenuation rates caused by water content are made to pass through plural bandpass filters selectively and are received, so that the attenuation proportion due to the attenuation factors other than water can be corrected, and it is possible to determine the water content of the object more accurately, and it is possible to provide a dryness detecting sensor for a clothes dryer.

[0054]

According to the invention as described in Claim 6, from the light irradiated on the object, plural wavelength regions with different attenuation rates caused by water content are made to pass through plural bandpass filters selectively, so that by receiving the light with light-receiving means corresponding to said wavelength regions, it is possible to correct the attenuation proportion caused by attenuation factors other than water, and it is possible to determine the water content of the object more accurately, and it is possible to provide a type of dryness detecting sensor for a clothes dryer.

[0055]

According to the invention as described in Claim 7, it comprises a light-receiving means for receiving IR light emitted corresponding to the temperature of the object and a control means that detects the outputs of said light-receiving means, so that it is possible to determine the water content of the clothes from the change in the output of said control means, and it is possible to provide a dryness detecting sensor for a clothes dryer.

[0056]

According to the invention as described in Claim 8 of the present patent application, the dryness detecting sensor for a clothes dryer is characterized by the fact that in the drum-type dryer that rotates and tumbles clothes in a drum to dry them, the light-emitting means and light-receiving means are set on the outside of said drum, and the incidence or blocking of the reflected or transmitted light with respect to said light-receiving means is performed by means of the holes formed in said drum. As a result, the characteristics with improved sensitivity of the current light-receiving elements with respect to the change in the intensity of light is exploited, and it is possible to provides a high-precision dryness detecting sensor for a clothes dryer.

[0057]

According to the invention as described in Claim 9 of the present patent application, the direction from which the air is blown from said air feeding hole onto said object is avoided while the clothes or other object is tumbled, so that it is possible to provide a high-precision dryness detecting sensor for a clothes dryer with reduced influence of air on light scattering, etc.

Brief explanation of the figures

Figure 1 is a block diagram illustrating the constitution of an application example of the present invention.

Figure 2 is a block diagram illustrating the constitution of the present invention.

Figure 3 is a diagram illustrating variation in the temperature inside the drum of the clothes dryer.

Figure 4 is a diagram illustrating the constitution of an application example of the present invention.

Figure 5 is a block diagram illustrating another constitution of the present invention.

Figure 6 is a diagram illustrating the constitution of the filter in an application example of the present invention.

Figure 7 is a diagram illustrating the relationship between the ratio of the detection light and the reference light and the water content of the clothes in the present invention.

Figure 8 is a diagram illustrating variation in the light receiving output of the reference light and detection light in the present invention.

Brief explanation of the part numbers

4	Control means
10	Light-emitting means
12	Light-receiving means
22	Dryer drum
24	Clothes

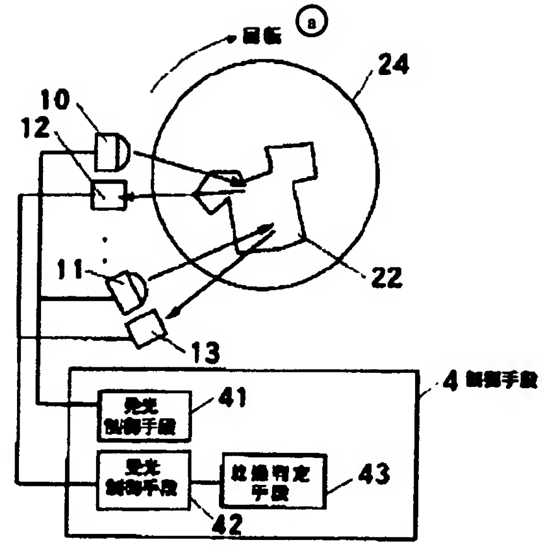


Figure 1

Key: a Rotation
4 Control means
41 Light-emitting control means
42 Light-receiving control means
43 Dryness judgment means

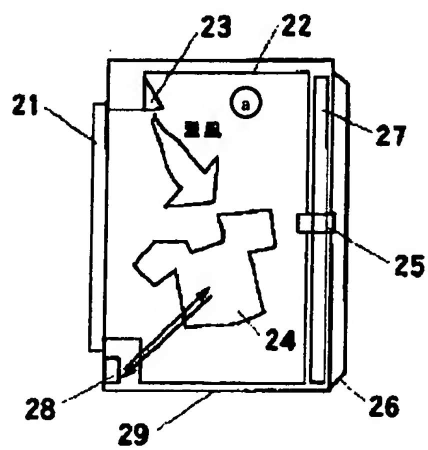


Figure 2

Key: a [illegible]

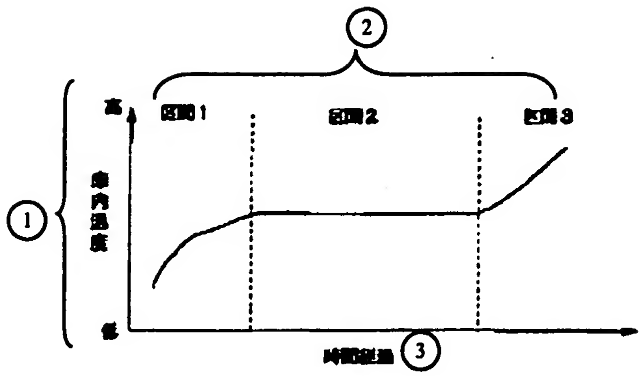


Figure 3

Key: 1 High
Temperature in drum
Low
2 Interval 1
Interval 2
Interval 3
3 Time

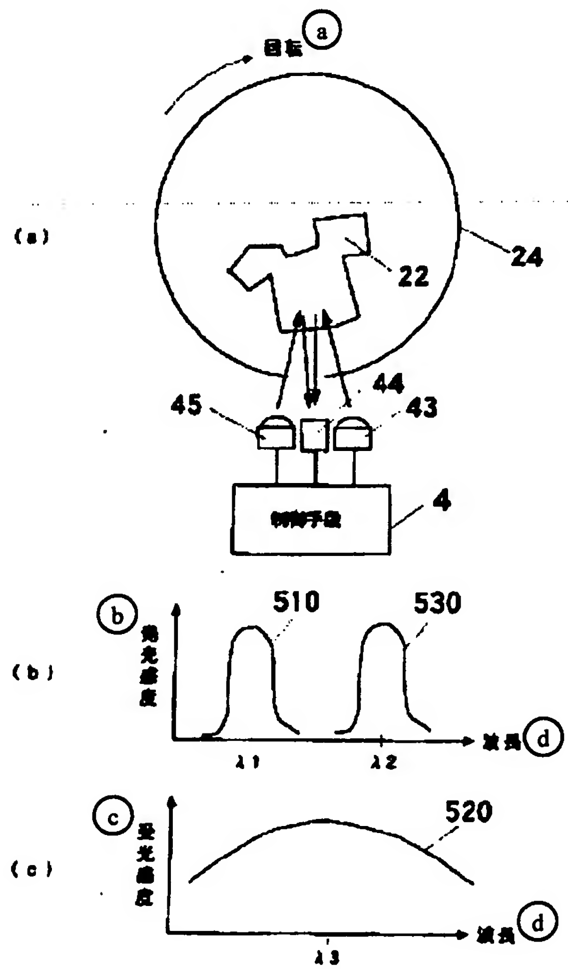


Figure 4

Key: a Rotation
b Light-emitting sensitivity
c Light-receiving sensitivity
d Wavelength
4 Control means

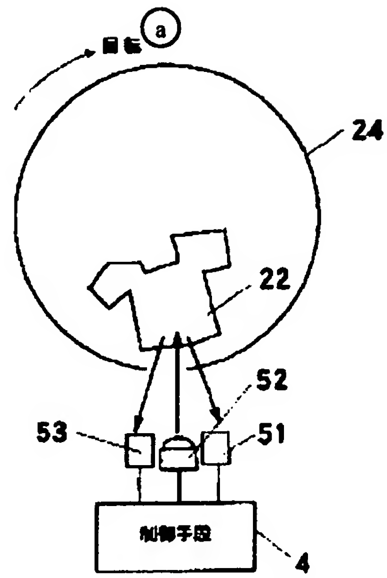


Figure 5

Key: a Rotation
4 Control means

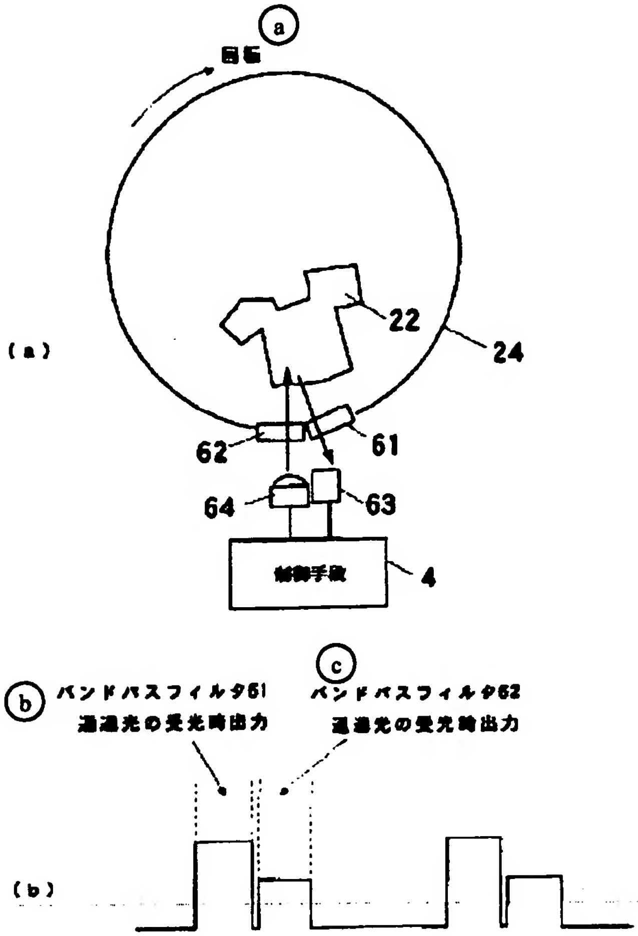


Figure 6

Key: a Rotation
b Light-receiving output of transmitted light with bandpass filter (61)
c Light-receiving output of transmitted light with bandpass filter (62)
4 Control means

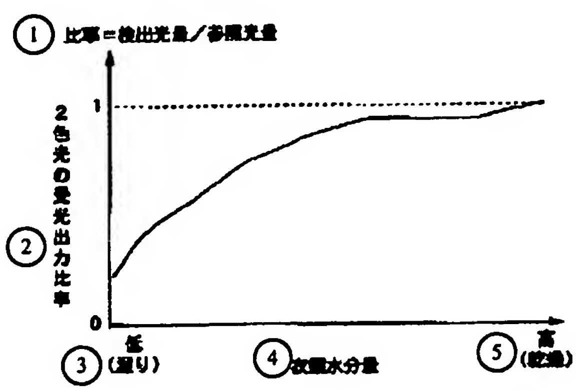


Figure 7

Key: 1 Ratio = detection amount of light/reference amount of light

2 Ratio of light-receiving output of 2-color light
3 Low (humid)
4 Water content of clothes
5 High (dry)

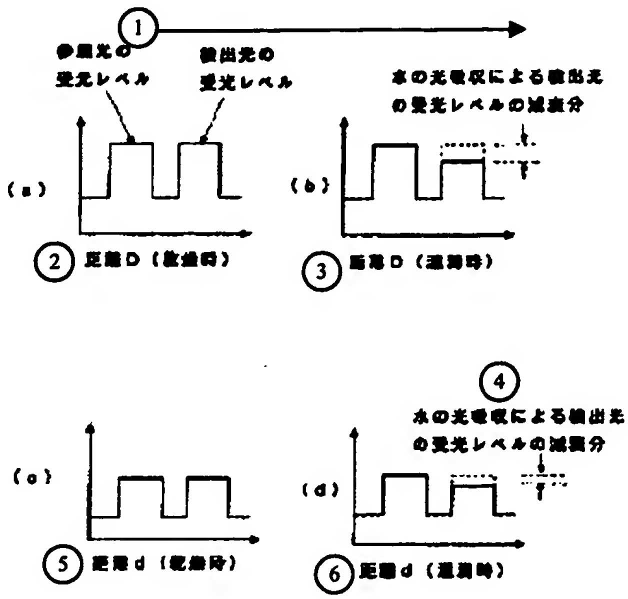


Figure 8

Key: 1 Light-receiving level of reference light
Light-receiving level of detection light
Attenuation proportion of the light-receiving level of the detection light due to light absorption by water
2 Distance D (when dry)
3 Distance D (when wet)
4 Attenuation proportion of the light-receiving level of the detection light due to light absorption by water
5 Distance d (when dry)
6 Distance d (when wet)